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Video Simulation for Training Land Design and Management

TRADOC Installations, Fiscal Years 1992-1993

by
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Video simulation technology is an evolving computer tool with important applications to Army training land design and management. As part of the implementation of the Integrated Training Area Management (ITAM) program, video simulation technology is being exploited and adapted for use by Army training land managers and designers. In this study, researchers from the U.S. Army Construction Engineering Research Laboratories (USACERL), Champaign, IL and Argonne National Laboratory (ANL), Argonne, IL developed, demonstrated, and evaluated the capabilities of video simulation technology for application to training land area management at Fort Benning, GA, Fort Huachuca, AZ, Fort Jackson, SC, and Fort Knox, KY. This research concluded that, by clearly showing alternatives before implementation, video simulations have the potential to: (1) increase effective communication between land managers and trainers, (2) reduce range construction costs, (3) aid installation master planners with range design, and (4) gain approval and consensus on project designs.

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Foreword

This study was conducted for Headquarters, U.S. Army Training and Doctrine Command (HQTRADOC) under Reimbursable Order No. EFC2E124. The technical monitor was Richard Blume-Weaver, ATBO-EL.

The work was performed by the Resource Mitigation and Protection Division (LL-R) of the Land Management Laboratory (LL), U.S. Army Construction Engineering Research Laboratories (USACERL). Richard M. Marlatt was the USACERL principal investigator and Thomas A. Hale was associate investigator. J.C. Douglas was a graduate research assistant associated with the University of Illinois, Urbana. Part of the research was done by Argonne National Laboratory (ANL), Argonne, IL under Military Interdepartmental Purchase Request (MIPR) No. 92-165, dated 13 April 1992. Robert E. Riggins is Acting Chief, CECER-LL-R, Dr. William D. Severinghaus is Operations Chief, and William D. Goran is Chief, CECER-LL. The USACERL technical editor was William J. Wolfe, Technical Resources Center.

COL James T. Scott is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

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Background

Army training land design and management must provide suitable training for Army units, yet minimize environmental damage from training activities. Thus, training area land managers are responsible for balancing training needs with environmental concerns. Achieving this balance requires a thorough understanding of training needs and an ability to incorporate reliable input from trainers and other experts into the training area design and management process. Furthermore, increasing public awareness and concern for Army land use makes it essential for training area land managers to be able to clearly communicate their design and management goals to the public in a format easily understood by nontechnical persons.*

Since the many parties involved in training land design and management issues have different (and sometimes competing) objectives and priorities, related issues must be aired clearly. Video technology can fill many of the needed communication goals; it can communicate technical information visually, in a simple, engaging form that is easy for both technical and nontechnical persons to understand. In fiscal year 1989 (FY89), the U.S. Army Construction Engineering Research Laboratories (USACERL) began developing ways to exploit and adapt emerging video simulation technology for training land design and management. Preliminary standards based on the DOS-based personal computer (PC) and compatible platforms were developed and evaluated to prepare specifications for system configurations. A resulting system consisting of an IBM AT-class microcomputer, TARGA 16 Graphics Adapter, and Truevision Image Processing Software (TIPS) became the basis for a demonstration at Hohenfels Combined Maneuver Training Center in Germany and for the USACERL Video Imaging (VI) Laboratory established in FY90.

The demonstration at Hohenfels (and later demonstrations at Fort Knox, KY and Fort Sill, OK) sufficiently established the utility of computer-based visualization tools for training land design and management to incorporate the use of this system into the Headquarters, Training and Doctrine Command (HQTRADOC) Integrated Training

* R.M. Marlatt, T.A. Hale, R.G. Sullivan, and R.M. Lacey, *Guidelines for Applying Video Simulation Technology to Training Land Design*, Technical Report EN-93/05/ADA264980 (U.S. Army Construction Engineering Research Laboratories [USACERL], February 1993).

Area Management (ITAM) Implementation Plan. The HQTRADOC plan recommended further research to demonstrate the capabilities of video simulation technology and its potential applications for managing training land areas at Fort Benning, GA, Fort Huachuca, AZ, Fort Jackson, SC, and Fort Knox.

Objectives

This objectives of this study were to develop, demonstrate, and evaluate the capabilities of video simulation technology for application to training land area management at Forts Benning, Huachuca, Jackson, and Knox, and to formulate recommendations for possible future application of the technology.

Approach

As part of the ITAM program being developed by USACERL, a three-phase research implementation approach was developed for video simulation for training land design. The first phase initiates test applications of videographic technology to assist with land management or training land design projects at installations. Based on the Phase I evaluation, a video-imaging workstation configuration and specifications are developed as a guide for fielding the technology at the installation. At this point, installation personnel decide whether the cost/benefit justifies installation of a workstation. If so, a complete imaging workstation is fielded and training support is provided in Phase II. Phase III consists of continued support to the installation and updates to the technology, including training as required, and opportunities to conduct video simulation for special project areas on the installation. Phase III also provides USACERL personnel critically needed feedback to further refine and develop the technology for land management purposes.

This study initiated Phase I for TRADOC during FY92-93:

1. Four installations were selected for inclusion in Phase I development of video simulation for training land design and management: Forts Benning, Huachuca, Jackson, and Knox. Primary selection criteria were: the existence of planned land rehabilitation projects, range expansion, or new range construction. An additional criterion for selection was the possibility of building on previous USACERL research to expand the usefulness of a project to installation personnel.

2. Installation ITAM points of contact (POCs) identified in the HQTRADOC Implementation Plan were contacted to schedule a site visit. On each visit, researchers presented an overview of video simulation technology and existing applications, and invited installation personnel to suggest applications that would be useful at their specific sites.
3. Researchers spent time at each installation to become familiar with the desired site-specific applications and to collect base image photography for later laboratory work.
4. Alternately, researchers electronically edited the base imagery and solicited feedback from installation personnel to realistically simulate land management actions and range designs.
5. The video simulations were presented to installation personnel for their use. Researchers briefed installation personnel on the process of creating simulations, and made recommendations for future use of the technology.

Scope

Development of standard hardware/software configurations for Army use of video simulation was beyond the scope of this project. While diverse applications were tested using a variety of different platforms and hardware/software configurations, specific equipment was chosen for reasons ranging from application requirements to the simple equipment availability at study sites. Standard configurations for video simulation will be derived at a later date. The citation of the following specific products and manufacturers is included in this report for information only, and is not meant as a product endorsement:

Product	Manufacturer
AutoCAD™	AutoDesk Inc., Sausolito, CA
Intergraph Microstation™	Intergraph Corp., Huntsville, AL
Level 29 XTC videographics adaptor	Number Nine Corp., Lexington, MA
PhotoStyler™	Aldus Corp., San Diego, CA
ScanJet IIc™	Hewlett Packard, Inc., Alto, CA
TARGA™ 16 Graphics Adaptor	Truevision Corp., Indianapolis, IN
Truevision® Image Processing	Truevision Corp., Indianapolis, IN
Windows®	Microsoft Corp., Redmond, WA

2 Overview

Video Simulation Technology

A variety of computer technologies, such as computer-aided drafting, geographic information systems, and videographics, are supplanting traditional tools for communicating the extent and impacts of large-scale planning activities, such as training area land design. The use of computer tools speeds the planning process and offers advantages of accuracy and flexibility in responding to changing circumstances.

Video simulation is one such powerful computerized visualization tool that is easily adaptable and well suited for training land design and management. In video simulation, base images from photographs, videotape, or 35mm slides are digitized into computer graphic files, which are then electronically "edited" or manipulated using specialized software. The edited image, or simulation, can be output in a variety of formats, including videotape, slides, and either color or black and white prints. The time it takes to produce a simulation ranges from 1 hour for simple simulations to several days for extremely complex ones. Although some graphic skills are required for most simulations, high quality simulations of this nature can be created by persons who are not professional artists.

The VI Laboratory established at USACERL explores, tests, evaluates, and enhances simulation capabilities for comprehensive Army training land design and management. Video simulation technology allows land managers and range personnel to simulate the appearance of proposed projects realistically and inexpensively before they are actually built. The video, or television, medium is familiar to land managers, Army trainers, and the public, and also provides a convenient way to obtain project input and feedback. Video simulation technology is also a versatile tool for public information and involvement.

Installation Selection

Mr. Robert Lacey, the USACERL Environmental Division program manager, and Mr. James Sabo, TRADOC, chose four installations to be included in Phase I development of video simulation for training land design and management applications. Primary considerations for selection included the existence of planned land rehabilitation projects,

range expansion, or new range construction. At Fort Knox, several new ranges were being designed for construction over the next several years, including the Wilcox Range (a high priority range project for the Army). The McKenna Drop Zone rehabilitation project and landfill at Fort Benning represented good opportunities for video simulations. Several erosion control projects were being coordinated with the Soil Conservation Service at Fort Huachuca, and Fort Jackson was designing a new marksmanship range.

Another consideration for site selection was the possibility of building on previous USACERL research to expand the usefulness of the current project to installation personnel. In FY89, USACERL had conducted preliminary research on the integration of a global positioning system (GPS), computer-aided design (CAD), geographic information system (GIS), and video-imaging technologies to increase the spatial and dimensional accuracy of simulations. Since Fort Knox served as the test bed for this research, it already had excellent elevation, GPS, and photographic data collected. Using that data in conjunction with new applications gave USACERL the opportunity to furnish Fort Knox with a unique and valuable product.

Procedure

In all cases, the installation ITAM point of contact identified in the HQTRADOC implementation plan was contacted to schedule an initial site visit. During this visit, researchers from USACERL presented an overview of video simulation technology and previous applications to give installation personnel a basis for suggesting applications that might be useful at their sites. Personnel representing natural resources, master planning, range division and Directorate of Plans, Training, and Mobilization (DPTM) were encouraged to attend these initial briefings.

USACERL personnel spent 2 to 3 days at each installation during these site visits to acquaint themselves with the suggested applications and collect base image photography for later laboratory work. Over the next several months, USACERL graduate research assistants electronically edited the base imagery to realistically simulate various land management actions and range designs. An iterative process ensued between the image editors and installation personnel as feedback was incorporated into the simulations to ensure accuracy.

Finally, the video simulations were presented to installation personnel for their use. The simulations took a variety of forms, including color video prints, 35mm slides, and video tape. Prints of the simulations are included in the Appendixes. USACERL personnel briefed installation personnel on the process of creating the simulations, made suggestions for their use, and recommended possible additional applications.

3 Evaluative Test Applications

Fort Benning

Background

The initial site visit to Fort Benning took place 14-16 October 1992. The initial presentation was made to Major John Orosz, Jr., Chief, Environmental Management Division, Directorate of Public Works (DPW) and to the following personnel within the Natural Resources Branch of the DPW: Jack Greenlee, Supervisor of Forestry; Alan Pursell, Land Condition Trend Analysis (LCTA) Coordinator; Charles R. Ford, Acting Chief; Thomas Brooks, Wildlife Biologist; and Serdar Ertep, GIS Specialist. Also present was Frank D. Harris, Range Specialist, Range Division, Department of Transportation (DOT).

Slides showing examples of visual simulations and GIS visualizations prepared for other installations were shown, as were prints and videotape. The visual presentation was followed by an in-depth discussion of the technology, including hardware, software, and skills and labor requirements.

The general reaction to the presentation was very favorable. Most of the audience had ideas about possible uses for the technology and specific suggestions for demonstration projects. Possible applications included both visual simulation projects and geographic data visualization projects, including range design simulations, public works simulations, and land reclamation visualizations. The GIS specialist, in particular, felt that videographic enhancement of images created by the Geographic Resources Analysis Support System (GRASS)* might be useful for producing high-quality GRASS output.

Finally, possible demonstration projects at Fort Benning were discussed, and two efforts were identified: (1) visual simulation of modifications planned for an existing Fort Benning landfill, and (2) visualizations of GRASS and CAD data layers for the

* James D. Westervelt, Michael Shapiro, William D. Goran, and David P. Gerdes, *Geographic Resources Analysis Support System (GRASS) Version 4.0 User's Reference Manual*, ADP Report N-87/22/ADA255218 (USACERL, 1992).

McKenna Drop Zone, an area of Fort Benning currently undergoing extensive reclamation activities.

Evaluative Applications

The simulation project for the landfill involved editing a "plan view" aerial photo of an existing landfill at Fort Benning. Proposed modifications to the landfill included additional capping of the top and sides of the landfill to increase the thickness of the cap by several feet. The additional capping required the extension of the toe of the slope on the sides of the landfill, which in turn required removing trees and shrubs that would be covered by the extended slope. Thus, the simulation would depict the landfill after re-capping, with the vegetation removed.

A stereo pair of high altitude aerial photos of the landfill and its immediate vicinity were obtained from Fort Benning. These were digitized using a high resolution color flatbed scanner. The two images were then electronically "spliced" together to make one image showing the landfill and surrounding area. The image was then edited using a blueprint of the proposed modifications to the landfill as a guide to prepare a simulation showing the post-construction appearance of the landfill (Figure A1). The finished image and the original image were output to a film recorder to create 35mm slides and also prints.

The visualizations of GRASS data for the McKenna Drop Zone involved creating three-dimensional views of topography created in GRASS, and depicting them as shaded-relief surfaces. For this effort, elevation data available for this area were used to create a shaded-relief surface in GRASS, which was then projected into 3D using the GRASS *d.3d* command. At this point, it was determined that the lack of topographic relief and the very small scale of the view (as necessitated by the size of the drop zone) meant that the resulting visualizations would be difficult to interpret because no topographic detail was visible. Additional visualizations were not created because, in this instance, videographic enhancement of the images would serve no useful purpose.

Discussion

The first simulation showing the altered landfill site was completed, reviewed by Fort Benning personnel, and approved for use. This particular simulation shows the flexibility of using this technology for aerial simulations. This perspective is generally only experienced through terrain maps, abstract GRASS data layers, and engineering drawings. A system that can create photorealistic simulations from this point of observation is a powerful communication tool that can augment other design or construction-oriented materials.

The intended simulations for the McKenna Drop Zone were useful for illustrating the methodology used for videographic enhancement of GRASS three-dimensional terrain data to Fort Benning personnel. While no final visualizations were created, this attempt helped determine criteria to identify terrain relief thresholds for future work. This criteria can help to quickly assess if videographic enhancement using a given set of elevation data would yield useful results.

Fort Huachuca

Background

During an initial site visit on 1–5 June 1992, USACERL researchers met with Mr. Clark Derdeyn, Chief, Game Management; Mr. Chris Cochran, ITAM Coordinator; and Mr. Ernest Beil, Chief, Range Division to present an overview of video simulation technology and discuss potential applications at Fort Huachuca. The response was positive and each participant generated several ideas for ways to apply the technology to their areas of concern.

The applications that were discussed focused on land restoration, repair, and maintenance with particular emphasis on strategies to mitigate soil erosion. Video simulation is an excellent tool to assist in visualizing the post-implementation appearance of proposed projects of this kind. The ability to clearly communicate what is intended allows people in other disciplines to understand and participate in the design and decisionmaking processes. Several projects were selected for use in developing video simulations that would communicate the design intentions and utility of each. Each project site was investigated and the proposed activities and probable environmental impacts were described in detail by installation personnel to ensure visual accuracy in the simulations (Appendix B).

Evaluative Test Applications

The first project site was located near the top of Huachuca Canyon at the source of a natural spring. Both Army and civilian vehicles use the stream bed as a way to ascend to Huachuca Peak, causing erosion and siltation that harm the riparian zone. To encourage re-establishment of the riparian plant community, it was proposed that a barricade be constructed to encourage vehicles to use an alternate route. A video simulation sequence was created by photographing the existing roadway from many angles and focal lengths to provide a wide array of slides from which to select base images. Slides were also taken at a similar area in Garden Canyon that had several

different species of flora representing the various successional stages in riparian community development.

Both sets of slides were scanned into computer graphic files and electronically edited to create new files showing the proposed changes. The sequence (Figures B1 to B3) shows the results over time if riparian vegetation were allowed to reestablish itself.

Another proposed project focused on mitigating surface erosion on a trail in the south range, which was making it increasingly difficult for vehicles to use the trail safely. The installation of water bars on this tank-worn trail with a steep grade would slow the surface water flow and reduce its energy. This straightforward simulation sequence was created by using specialized paint tools to edit scanned images of the site. The water bars were created using textures and colors from within the base image (the original image from the site) as opposed to importing pieces from an electronic library image (separate images of trees, tanks, or erosion control structures, for instance). This sequence (Figures B4 and B5) shows the appearance of the site before and after the water bars are installed and the effect the water bars would have on surface erosion.

A third project shows a land management action (reshaping and contour replanting) being implemented on the east range. Since it is much lower in elevation and rainfall, the east range has sparse vegetation and exposed soil common to arid regions, which makes it highly susceptible to training-induced erosion. In addition, heavy spring rains move tremendous amounts of unstabilized soil causing large erosion rills and gulleys. Areas with a high potential for erosion are regraded and replanted with tough perennial grasses to stabilize and protect the soil. Seed is sown in long rows, resembling contour lines on a map.

The simulations for this sequence were accomplished by importing images of newly installed contour plantings from another area into an image of the area proposed for similar work. Careful editing was required to maintain existing shrubs and shadows. These four simulations (Figures B6 to B9) show two different options for consideration by land managers and trainers: one removes all existing large shrubs to facilitate earth grading and replanting, and the second leaves existing vegetation. The first option is more cost effective since wider equipment can be used, while the second option might offer an advantage to the trainers of maintaining the natural terrain. The use of video simulations provides visual information on which to base better decisions.

The fourth project focused on a possible solution to a problem identified by Mr. Beil, who was concerned about emergency or rescue vehicle response times when travelling

on Garden Canyon Road. The road intersects several intermittent streambeds; each ford has a concrete pad and sharp dip to provide a channel for water to flow after heavy rains. Emergency vehicles must slow down considerably to cross these stream beds or stop completely in case of flooding. Mr. Beil's proposal was to construct a simple bridge at grade at each of these points to eliminate the sharp dip, which would allow emergency vehicles to pass more safely and quickly. The simulation was conceptual in nature, since no design had been identified for the actual structure, but the purpose was to communicate the idea to others for their understanding and review. The bridge itself was fabricated by using the painting and editing tools available with the video-imaging software. Such visual information can be used to gain project approval and appropriate funding support (Figures B10 and B11).

Discussion

The imagery collected during the initial site visit in June 1992 was used by USACERL personnel to prepare draft video simulations for installation feedback. Draft simulations of the first two evaluative applications discussed above were given to Mr. Cochran, the Fort Huachuca ITAM coordinator, for review. They were approved and used to brief other environmental personnel on post and at the Soil Conservation Service office in Tucson.

The three remaining applications required more effort and additional imagery to complete. Mr. Cochran obtained the imagery and sent it to USACERL for incorporation into the simulations, which were reviewed at a later date.

The simulations were output in a variety of formats, including both color and black and white prints, 35mm slides, overheads, videotape, and electronic slide shows. This flexibility aided the iterative process used to create the simulations. Draft simulations were printed in color and black and white for review. Comments, encouraged both in written form and directly on the prints, were incorporated directly into the simulations as they were finalized. The evaluative applications performed at Fort Huachuca were considered successful by all involved and were especially helpful in promoting several training area reclamation projects.

Fort Jackson

Background

Before visiting Fort Jackson for the initial presentation of the technology to Directorate of Public Works (DPW) personnel, 35mm slides of landscape scenes were

chosen for editing, according to verbal instructions provided by Fort Jackson personnel. The selected scenes showed badly eroded slopes and roadsides at the "Anzio site," a small arms range at Fort Jackson. The edited simulations depicted hypothetical post-revegetation appearance and were shown to the audience at the initial site visit presentation 21–25 September 1992.

Researchers from USACERL made the site visit and presentation. The initial presentation was made to the following Fort Jackson personnel: Mark Dutton, Chief, Land Management Branch, DPW; Doyle Allen, Soil Conservationist, DPW; and Captain J. Grimsby, Chief, Directorate for Plans, Training, and Mobilization. In addition, various members from other branches within the DPW (including master planning and environmental management), as well as representatives from the South Carolina Army National Guard were present.

Slides showing examples of visual simulations and GIS visualizations prepared for other installations were shown, as were the prints of the previously discussed simulations and videotape. The visual presentation was followed by an in-depth discussion of the technology, including hardware, software, and skills and labor requirements. Finally, possible demonstration projects at Fort Jackson were discussed, and a tentative effort involving visual simulations was identified.

The general reaction to the presentation was very favorable. Most of the audience members had ideas for possible uses for the technology and specific suggestions for demonstration projects. Possible applications included both visual simulation projects and geographic data visualization projects, including range design simulations, public works simulations, and land reclamation visualizations. During the site visit, photographs were taken at some of these sites for use in a planned simulation demonstration project, but the project was not carried out, in accordance with Fort Jackson DPW staff's requests (see below).

Evaluative Test Applications

The draft simulations of the small arms range, produced before the initial presentation, were output as 8.5 x 11-in. thermal prints using a color Postscript-compatible printer (1 in. = 25.44 mm).

During the initial site visit, DPW indicated that they wished to have a system capable of geographic data visualization transferred to Fort Jackson as soon as possible. The land management office at Fort Jackson already had a suitable 486 DOS-based PC, monitor, a Hewlett Packard Scanjet IIc color flatbed scanner, and a Postscript-compatible color thermal printer, so that, except for a suitable videographics card, the

main components of the videographic system were already in place. Fort Jackson personnel decided that video capture and output capabilities were not critical at that time. USACERL agreed to provide a suitable 24-bit video card and Windows-compatible image editing software that would be specified in concert with ANL after a testing and selection process.

The components that were eventually selected were: a Number Nine Corporation Level 29 XTC videographics adapter card, and Aldus Photostyler software for use in image editing. These components were installed at Fort Jackson 3–5 March 1993.

During this same visit, Fort Jackson personnel received 2 days of training in the operation of the video card, scanner, printer and Photostyler, as well as techniques and tips for image scanning, printing, and image editing. Techniques for GIS image enhancement were also reviewed and demonstrated. An attempt was made to translate GRASS images into a suitable format for importing into Photostyler, but due to missing GRASS-related software and network problems, this could not be accomplished.

Shortly after this visit, DPW indicated that they would prefer additional training for their personnel on advanced uses of the videographic system instead of additional evaluative simulation work. The additional training was given during a 3-day site visit 10-12 May 1993, which focused primarily on geographic data visualization. All GRASS-related software necessary for translating GRASS images into formats compatible with Photostyler was installed. Some instructions in the use of GRASS and UNIX were also provided so that DPW personnel could create views in GRASS suitable for enhancement with the videographic system. File creation in GRASS was reviewed, as was file translation, porting of files over the network, importation into Photostyler, and enhancement of the images in Photostyler. Additional review of Photostyler and visual simulation techniques were also provided, as was further instruction in printing and scanning. A significant amount of time was spent attempting to remedy network problems that effectively cut off the videographic system from the other devices on the network. A temporary fix was achieved, but DPW personnel were advised that a functional network was important to effectively use the videographic system for GIS image enhancement, and that they would need to provide their own long-term solution.

Discussion

Transfer of videographic technology to Fort Jackson was successful. The hardware and software necessary to create video simulations and to do GRASS output visualization and enhancement was currently in place. Two training sessions were conducted for Fort Jackson personnel covering the skills necessary to accomplish a

broad spectrum of simulation types, techniques, and applications. The only remaining issue was the integration of videographic hardware with existing network hardware. These familiar conflicts have been resolved before through efforts between USACERL researchers and installation network administrators.

Fort Knox

Background

Fort Knox personnel were among the first to be introduced to video simulation for Army training land management when USACERL began testing the feasibility of combining video simulation with CAD, GIS, and GPS technologies for an integrated approach to visual simulation. Fort Knox was selected as a test site location for its remarkably accurate terrain elevation data. The hypothetical impact simulated was a "clearcut" on a forested hillside in a tank range. The present work builds on this early test, but focuses on working with installation personnel to create simulations for their use and to evaluate the potential applications.

During an initial site visit from 31 August to 3 September 1992, USACERL personnel and ANL contractors met with Fort Knox personnel representing a broad spectrum of the DPW and Range Division, including master planning, ITAM coordination, environmental management office, cultural/natural resources, and the armor school. Installation personnel were enthusiastic about possible applications for video simulation, which included planned ITAM projects at training areas 8, 9, and 10, projects at historically significant village sites, several range projects, joint land use program, and a vegetation barrier along Highway 313. The consensus was that video simulation was a tool that everyone could use. It was agreed that USACERL would proceed with evaluative applications of the ITAM projects, the Highway 313 vegetation barrier, and the Wilcox Armor Long Range Gunnery/Maneuver Complex (MPRC-H) currently being planned.

A separate briefing was given to the Range Division and the idea of simulating the design for the Wilcox Range was discussed in detail. Mr. Andy Andrews, Chief, Range Division asked that USACERL prepare a viewshed analysis 35mm slide for his use in briefing the project to the approval board for MCA projects. Andrews expressed the opinion that video simulations had the potential to save much money in construction costs before implementation of the several ranges they were planning by providing the capability to preview appropriate training land designs. As an example, he mentioned one range at Knox where the targets had become unusable because the designers had not paid enough attention to terrain.

Each of the proposed sites for the evaluative test applications was visited with appropriate installation personnel who could explain in detail what was being proposed for the site. USACERL personnel then collected the necessary imagery from each site and gathered pertinent maps, aerial photos, CAD drawings, and plans from installation personnel. The test applications are discussed below. Appendix C shows proposed changes and outputs.

Evaluative Test Applications

After discussing various technical issues and listing possible demonstration projects, an application was selected to demonstrate how videographics might be used at Fort Knox. This project involved producing visual simulations of modifications planned for a stream crossing used by heavy vehicles. The crossing consisted of dirt trails sloping down to a natural rock stream bottom, approximately 6 in. deep. The trails on either bank of the crossing had been widened extensively by vehicles avoiding muddy spots in the middle of the trails. The widening resulted in severe damage to roadside vegetation, and had formed even more mud holes, further widening the trails. This loss of vegetation caused erosion and sediment deposition in the stream.

The ITAM coordinator planned to pave the trails on either side of the crossing with gravel, to reduce pothole formation and to discourage off-road travel. Denuded trailside areas would also be replanted to slow erosion. The simulations for the videographic demonstration project were to depict the new crossing with gravel and restored vegetation from several viewpoints.

During the initial site visit, 35mm slides of the crossing were taken from both sides of the stream at several distances. These slides were scanned and the resulting files were then edited to reflect the proposed changes and output as slides and prints (Figures C1, C2) for review by the ITAM coordinator.

In addition to the general presentation described above, another presentation was made to the Fort Knox Range Control staff. Among others, this presentation was attended by Dale Kersey, Range Facility Engineer and Andy Andrews, Chief, Range Division. The presentation was similar to the previous one, but it focused more closely on past Fort Knox applications and less on applications at other installations.

The presentation to Range Control resulted in plans to conduct a demonstration project involving visualizations of a range complex proposed for construction at Fort Knox. This project required production of graphics for use in briefing the Construction Requirements Review Committee (CRRC), in a yearly review of major construction

projects at U.S. Army training installations. In this case, the project was a major long-range maneuver and gunnery complex known as the Wilcox Range.

GRASS is used at Fort Knox for a variety of land management activities, and images were desired for the Wilcox Range CRRC presentation that would demonstrate the use of GRASS in range planning. More importantly, images were needed to help communicate the design concept for the complex so that the review committee could clearly see and understand it in the brief time allotted.

To address these needs, it was decided to overlay a CAD model of the range complex design onto various GRASS data layers. Eventually both a plan view of a GRASS shaded-relief model of the impact area, and 3D perspective view of GRASS soils data were used as base images for the CAD model overlays.

The GRASS command *shade.rel.sh* was used to generate the shaded-relief model of the impact area, and *d.3d* was then used to create the 3D perspective view of shaded relief that was used as a base for the perspective-view final image. Dale Kersey, the Fort Knox POC for the project, selected the appropriate viewpoint and viewshed for the final view from a series of possible views. In addition, a 3D perspective view of local soil polygons was created for eventual overlay onto the shaded relief map.

Various vector data layers such as roads and streams were rasterized and then projected using *d.3d* so that they could also be overlaid onto the image to provide contextual information. Coordinates for the corners of the proposed complex site were then screen-digitized using the GRASS *r.digit* command, and this data was also projected using *d.3d*.

The GRASS 3D and plan-view images were converted to Sun raster images using the UNIX *screendump* command. These files were then converted to a PICT file format, acceptable for subsequent processing on other platforms.

The various layers for both the plan and 3D views were graphically overlaid onto the shaded-relief maps, creating composite shaded-relief maps showing roads, streams, lakes, and the outline of the maneuver complex. In the three-dimensional perspective view, the transparency of the soils layer was adjusted so that shaded relief would be visible underneath the soils polygons.

The CAD conceptual model of the maneuver complex was obtained from the Huntsville Division, Corps of Engineers Office in Intergraph Microstation DGN format. This file was converted to DXF format, a standard CAD format, and then imported into AutoCAD. In AutoCAD, a 3D perspective view of the model was created, using the

same viewing parameters as were used for the GRASS 3D views of the impact area. This file and a plan view of the model were then plotted to a TIFF format for further manipulation using videographic software.

The CAD files were then overlaid onto the composite shaded-relief maps, using the GRASS-generated maneuver complex outline to guide the overlay process. The final step in the editing process was to add labels and legends to the images, and then write them out to PICT files for printing. The images were output as both 35mm slides (using a film recorder) and prints (using a dye sublimation transfer printer).

Discussion

The images were presented at the CRRC briefing in June 1993 along with other slides and materials relevant to the maneuver and gunnery complex construction project. The CAD-GRASS overlay visualizations were well-received, and the project was approved. Dale Kersey expressed the opinion that visualizations were of significant value in communicating the design concept for the project, stating that "The graphic presentation produced the level of understanding needed to gain approval for this $20,000,000 construction project."

Figure C3 shows the plan view of the maneuver complex conceptual design. Figure C4 shows the 3D view of the maneuver complex with GRASS-derived soils data overlaid onto shaded-relief. Roads, streams, and lakes are also shown to provide context. The overlay of the maneuver complex onto the topography facilitates an understanding of the relationship of the complex to major landforms and pre-existing facilities at Fort Knox such as the road network. Individual range components such as moving and stationary target locations and the main firing line can easily be related to both local topography and local soil types.

Transfer of videographic technology to Fort Knox may result in successful applications of the technology for a variety of purposes. Fort Knox is a large enough installation so that there is usually a variety of land management and/or construction activities underway. The videographic system could frequently be used to good effect, if desired. Fort Knox is also a high-visibility installation, and environmental and construction activities are sometimes subject to close scrutiny by regulators and the public, another situation that lends itself well to use of videographic technology for both visual simulation and geographic data visualization. There also seems to be sufficient capability and interest in the technology among installation personnel.

4 Conclusions and Recommendations

Conclusions

This study developed, demonstrated, and evaluated the capabilities of video simulation technology for application to training land area management at Forts Benning, Huachuca, Jackson, and Knox. Without exception, personnel at each installation found many uses for the technology, spanning a broad spectrum of functions within the Directorate of Public Works (DPW). The results of this demonstration indicate that video-imaging technology has the capacity and flexibility for use as a department-wide resource for land management and also to support the areas of master planning, buildings and grounds, and the services provided by the Directorate of Plans, Training, and Mobilization (DTPM). Range Control could also contribute much to the development of a useful video simulation system, and benefit from using such a system for communicating range and training land design needs with essential DPW components. Lack of manpower in any given branch or group may prevent a video-imaging system from being used to its full potential, but this limitation could be easily overcome if a video-imaging system were implemented as a shared resource.

The test applications were accomplished using a variety of different platforms and hardware/software configurations. Not all the platforms used in this study were essential to the task, but their use showed that the needed tools could be easily ported between diverse platforms, and that systems could be built to take advantage of the strengths of different existing video-imaging technologies. This research contributes to a body of knowledge that will make video imaging available to installations in the form of customized, integrated systems that reflect specific installation needs and existing technological capabilities.

Recommendations

It is recommended that video-imaging systems be fully implemented at Forts Benning and Knox, partially implemented at Fort Jackson, and not implemented at Fort Huachuca at this time.

Transfer of videographic technology to Forts Benning and Knox is likely to result in successful applications of the technology for a variety of purposes. Forts Benning and Knox are large enough so that there is usually a variety of land management, range and training land design, and construction activities underway. Under such conditions, a videographic system would likely be used frequently. Fort Benning is a high-visibility installation where environmental and construction activities are sometimes subject to close scrutiny by regulators and the public, a situation that lends itself well to use of videographic technology for both visual simulation and geographic data visualization. Fort Knox is also a large installation, home of the ARMOR school, and a location involved in several major range construction projects that warrant use of the technology for simulation and visualization needs. Personnel at both installations have shown sufficient capability and interest in the technology so the system would be used effectively and continuously.

Managers could use one of two strategies to alleviate the staffing concerns that might accompany the added responsibility of creating video simulations. First, one individual might be assigned to full- or part-time operation of the system. Any part-time assignment must be of sufficient hours-per-week to ensure that the operator becomes proficient at using the system. This person would have primary responsibility for preparing simulations/visualizations in conjunction with other staff members' projects. An ideal candidate for this position would be the installation GIS specialist, an individual already conversant with computer technology, and with the necessary skills to learn the system quickly.

The second alternative would be for managers to require staff to create the simulations and/or visualizations for projects on an "as-needed" basis, and to allot sufficient time when planning the project for staff to create the simulations. This "on-the-job" strategy would force staff members to become proficient with the system without giving them an additional, separate workload. An added incentive here would be to point out to staff members during initial training that the imaging system can also be used for a myriad of other functions in an office setting (e.g., graphics, presentation materials, etc.). Doing these activities would further acquaint them with the capabilities of the system and prepare them to do simulation and visualization work as the need arises.

The appropriate strategy should be chosen in consultation with installation managers and staff. Hiring a full- or part-time staff member to operate the system may an ideal, but impractical strategy for various reasons. Requiring staff members to use the technology as part of their project work would encourage them to visualize projects as finished products and to note possible conflicts and problems before beginning implementation or construction. It might also act as a catalyst to encourage more

communication between different groups during the planning and design process, thus becoming a true resource available to the whole DPW.

For regular DPW staff without extensive computer graphics training to use the system, it must be simplified as much as possible, while retaining versatility. Such a system would not include video input/output, but instead a 24-bit display adapter. All Windows-compliant software would be specified. One scanner would be included, preferably a flatbed scanner. A Postscript-compatible thermal printer would be specified. This is the recommended system configuration for both Fort Benning and Fort Knox.

After discussion with Environmental Branch Management at Fort Benning, it was decided that a system using Windows-based editing and graphics software would be specified for their simulation and videographic needs. This system will represent a hybrid of advanced videographic technologies now becoming available. While much simpler to use than its predecessors, this system will retain the power and flexibility required for advanced simulation, visualization, and modeling work.

Though a complete video simulation system is recommended for implementation at Fort Knox, one is not currently scheduled due to inadequate funding.

Fort Jackson is a relatively large installation with a relatively small staff available for land management and related activities. While installation personnel have shown sufficient capability and expressed enough interest in the technology so that the system could probably be used effectively, additional technology transfer assistance of the videographic system from USACERL to Fort Jackson is recommended before such a system should be implemented there. This assistance should not focus so much on honing the environmental staff's technical skills as on helping integrate the system's inherent processes for visualization, communication, and decisionmaking into the network of normal function between DPW groups. If video simulation is to be used, it should be integrated as a familiar, daily task. This integration and expansion of applications to use the videographic system will help ensure the system longer continued use and usefulness.

Implementation of a videographics workstation is not currently recommended for Fort Huachuca primarily due to decreasing staff size at that installation. The extensive simulations prepared for Fort Huachuca personnel were well-received, but an adequately sized environmental staff is necessary to cover the day-to-day requirements of learning and keeping current with the use of a simulation system.

Appendix A: Output for Fort Benning

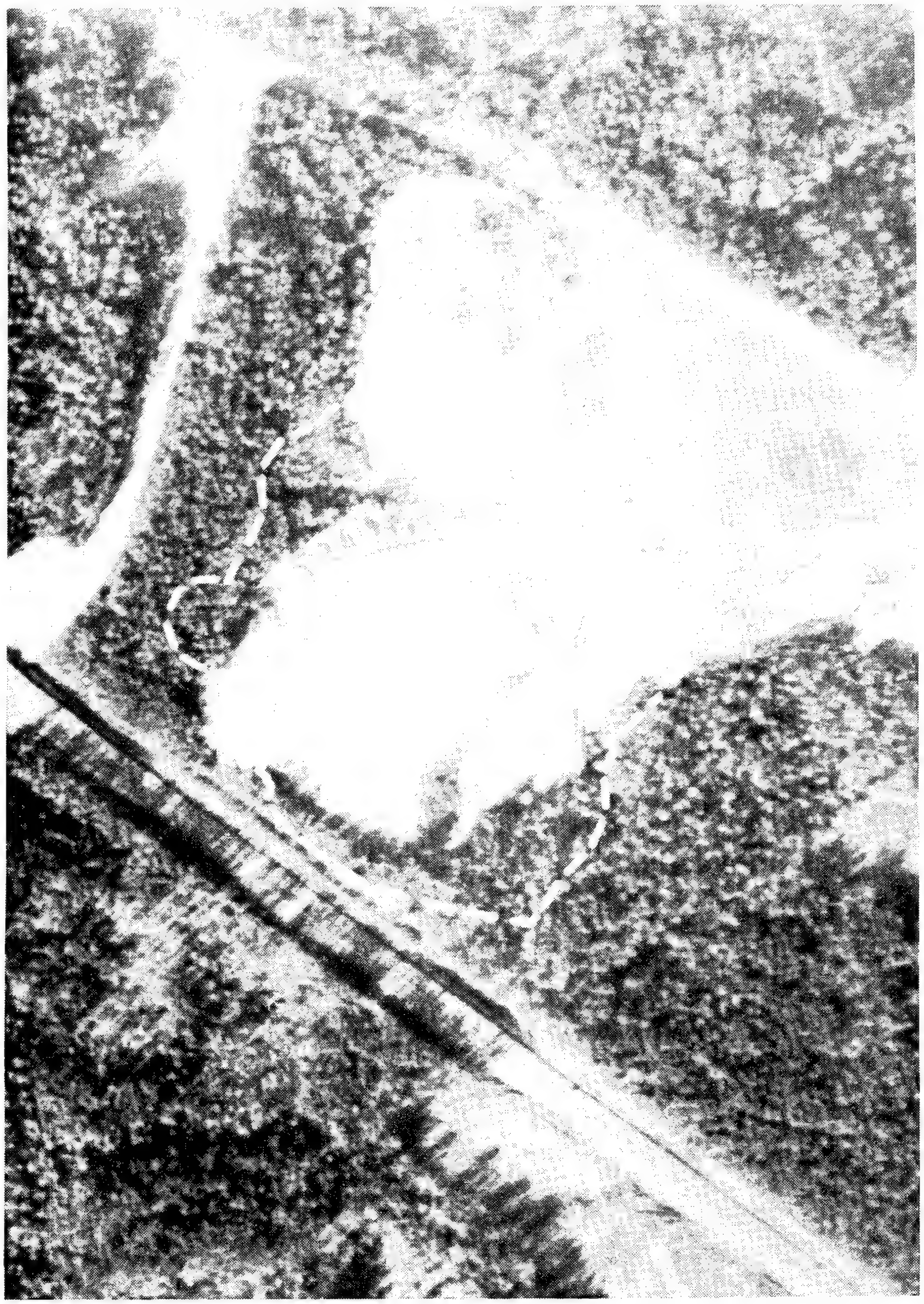

Figure A1. Simulated landfill at Fort Benning, GA.

Appendix B: Output for Fort Huachuca

Figure B1. Existing view of Huachuca Canyon access road, Fort Huachuca, AZ.

Figure B2. Simulated view of Huachuca Canyon access road 1 year after rehabilitation.

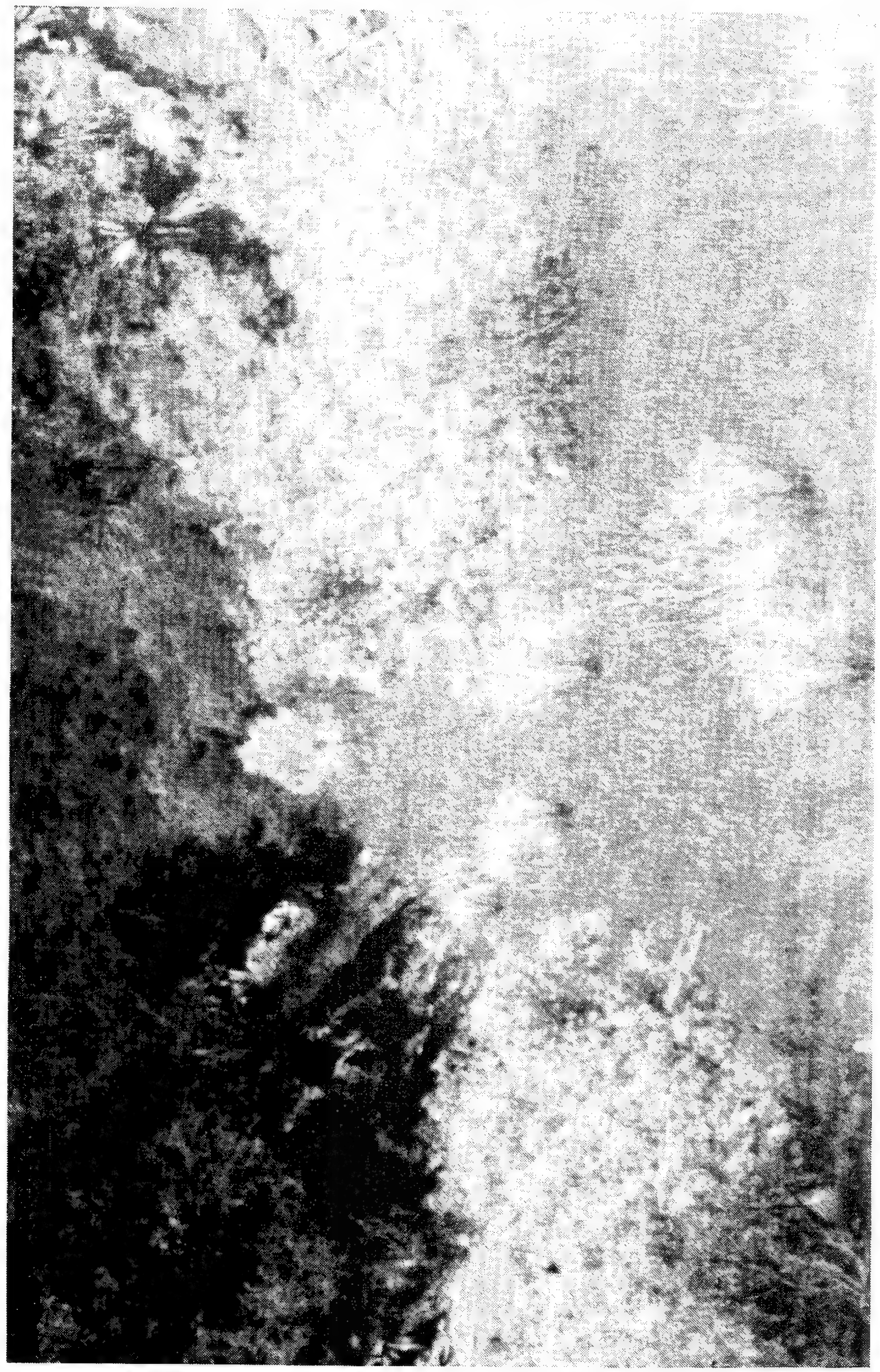

Figure B3. Simulated view of Huachuca Canyon access road 10 years after rehabilitation.

Figure B4. Heavily eroded tank trail on the south range.

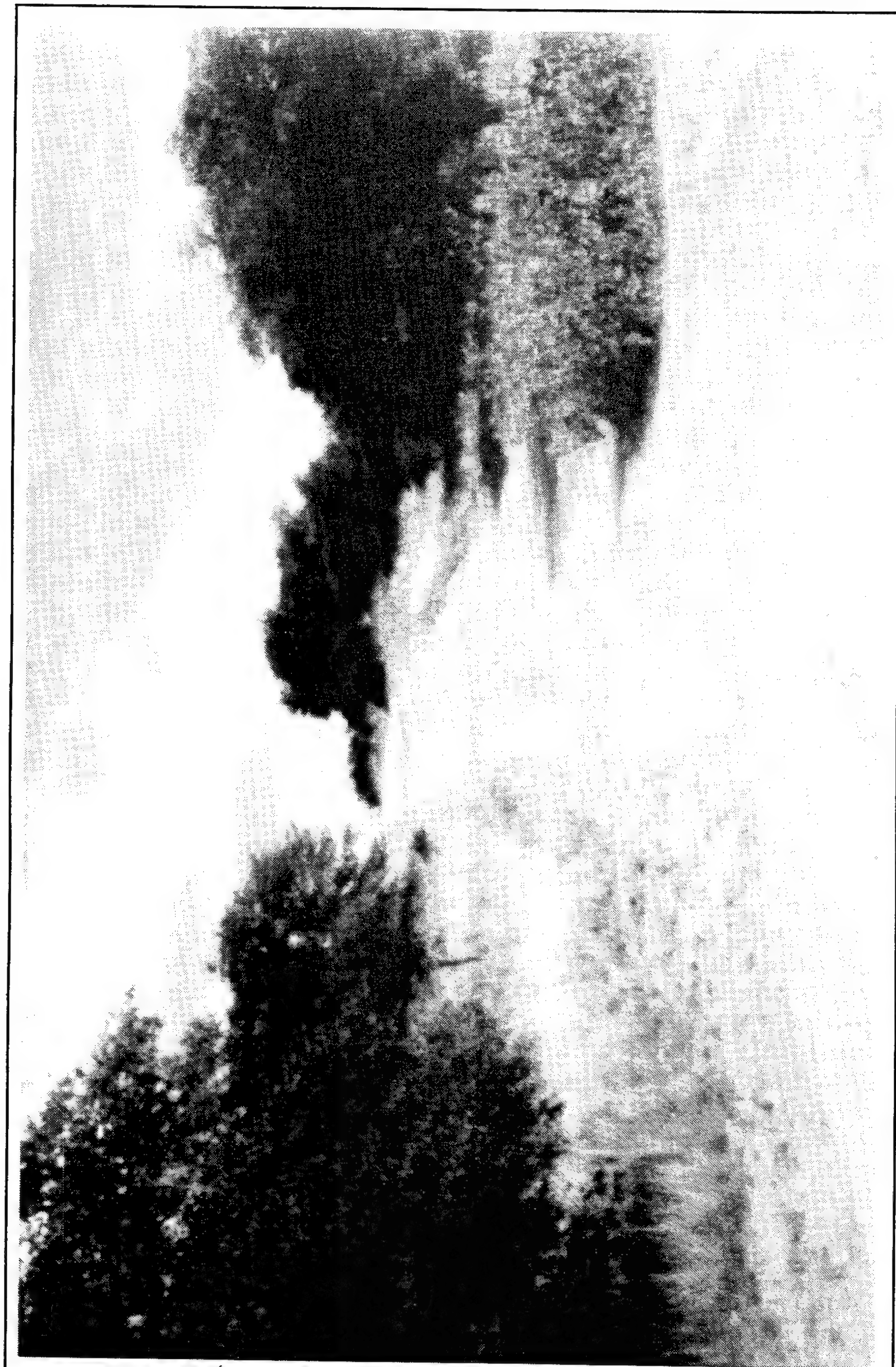

Figure B5. Simulation of tank trail after installation of water bars.

Figure B6. Existing view of training area on the east range.

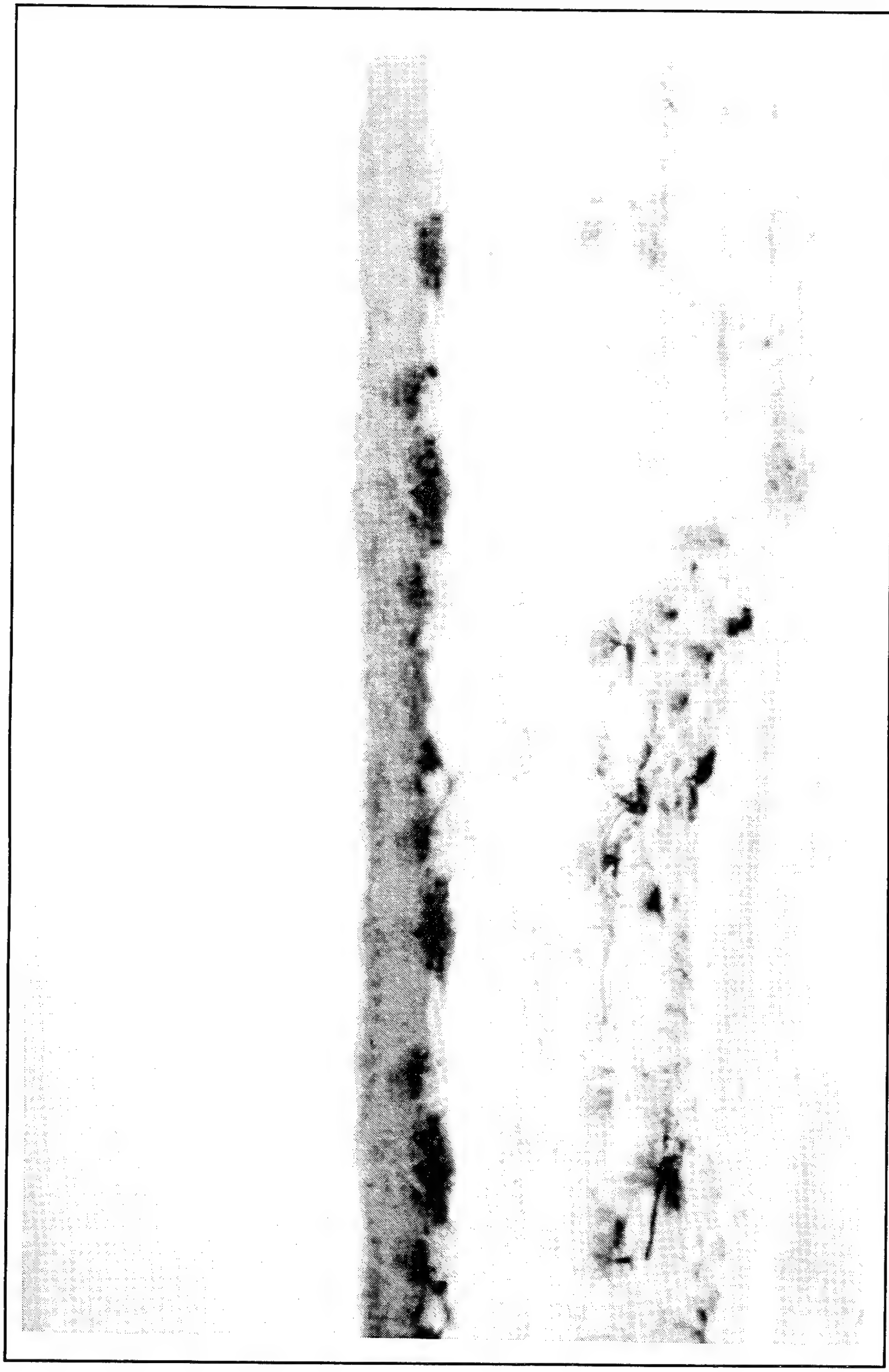

Figure B7. Simulated view: removal of large shrubs.

Figure B8. Simulated view: revegetation using "contouring" method.

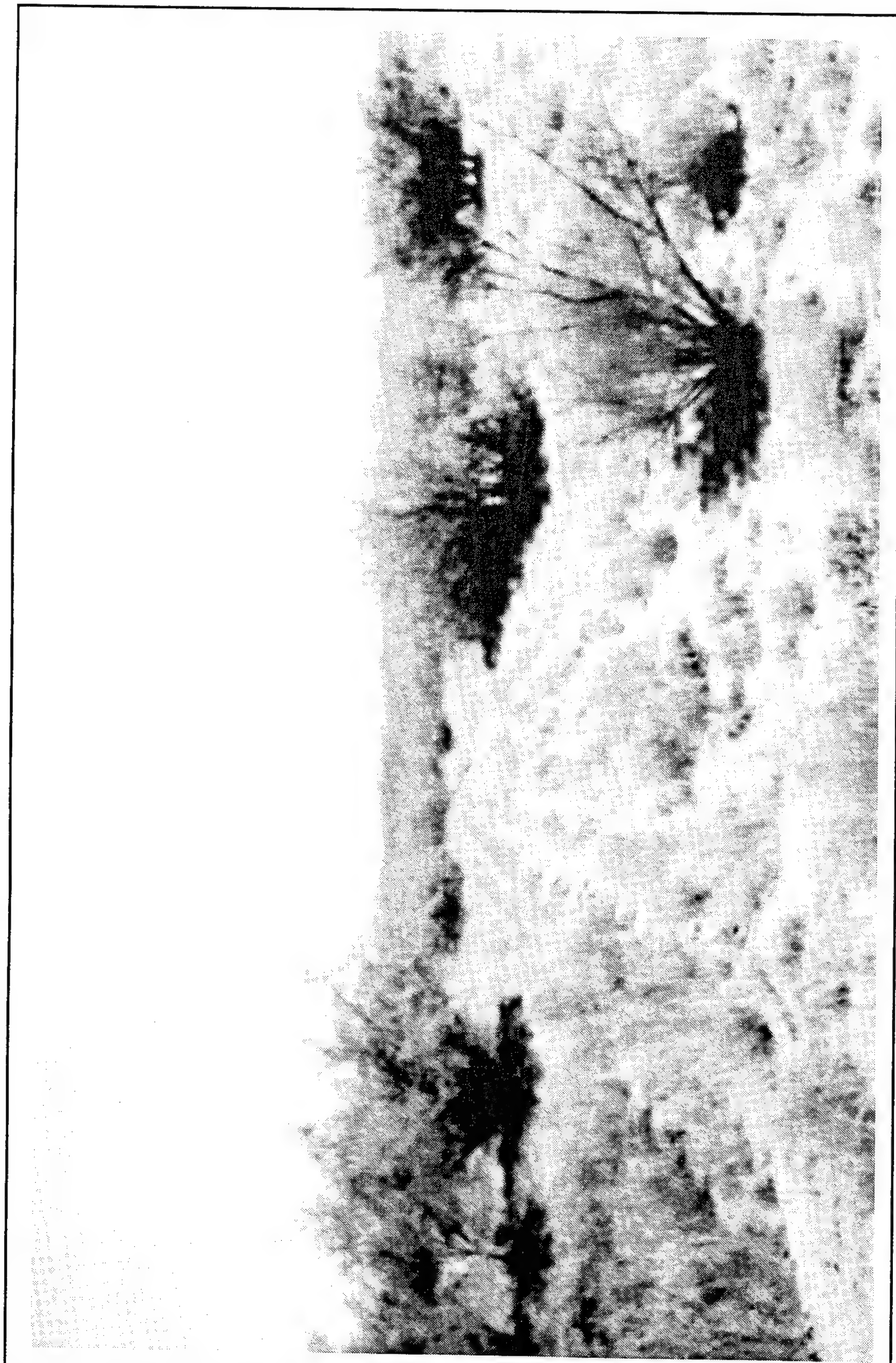

Figure B9. Simulated view: revegetation around existing shrubs.

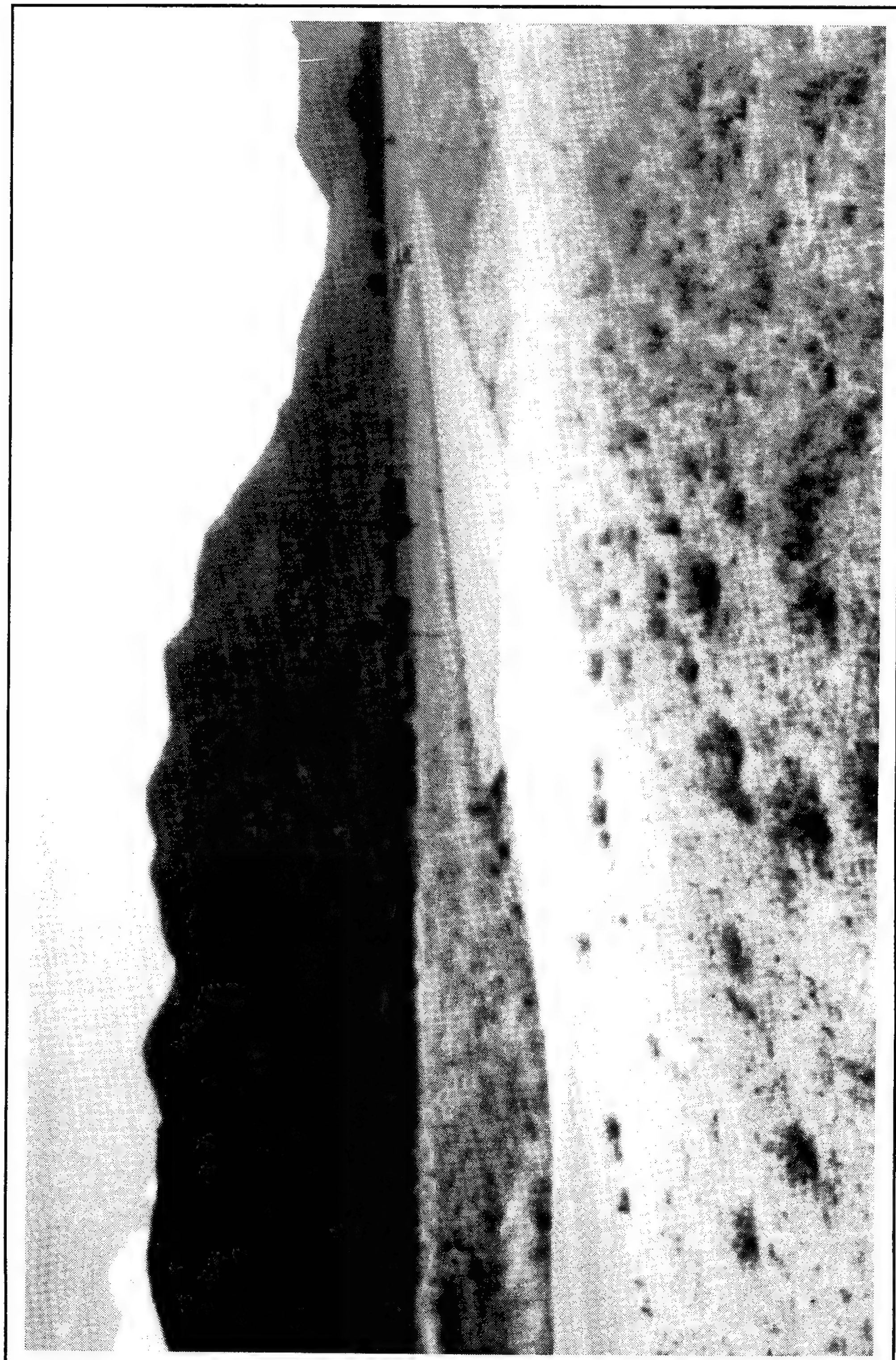

Figure B10. Existing view: Garden Canyon Road.

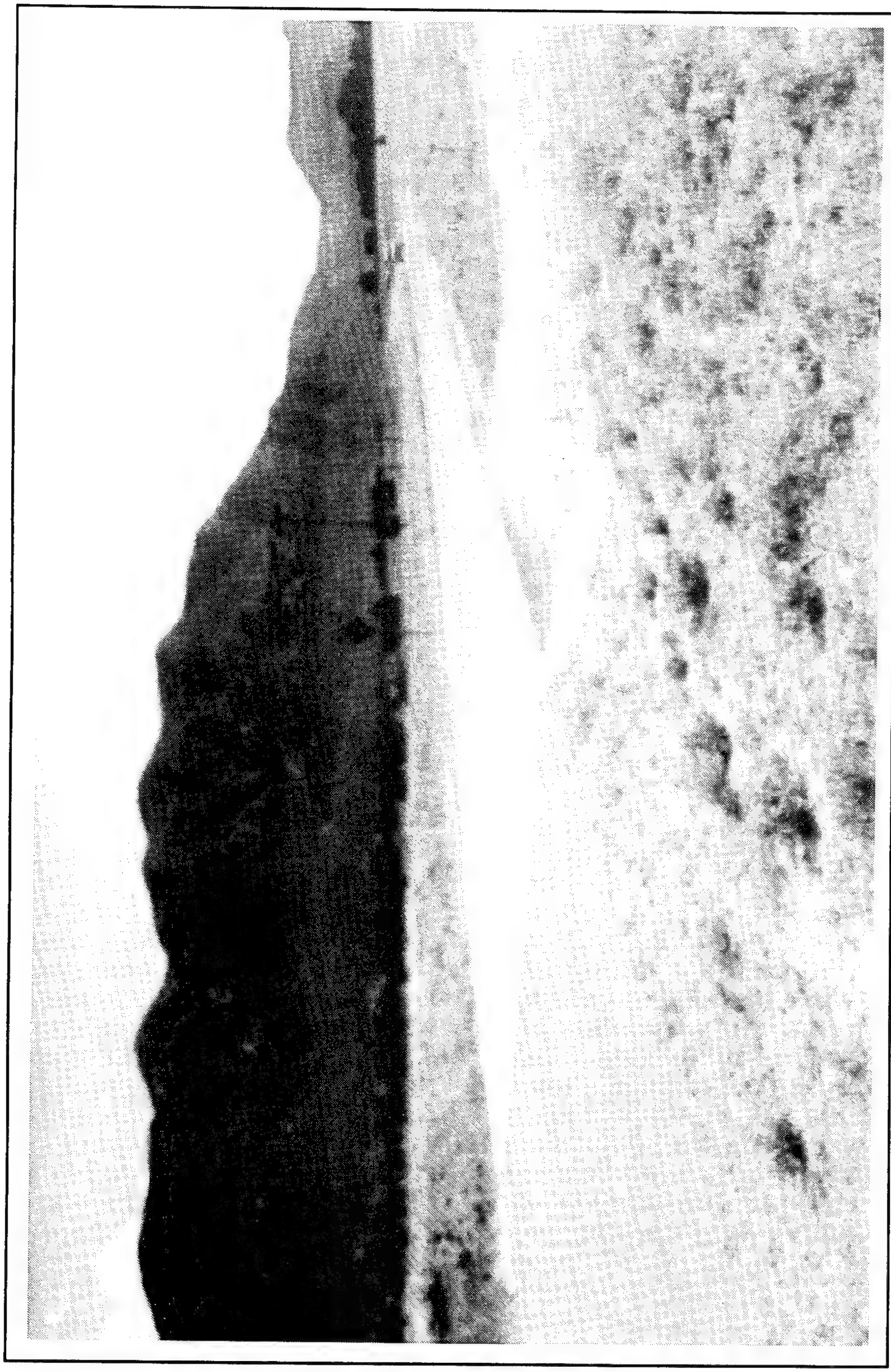

Figure B11. Simulated view: bridge installed to facilitate emergency vehicle passage.

Appendix C: Output for Fort Knox

Figure C1. Existing view: degraded stream crossing, Fort Knox, KY.

Figure C2. Simulated view: rehabilitated stream crossing.

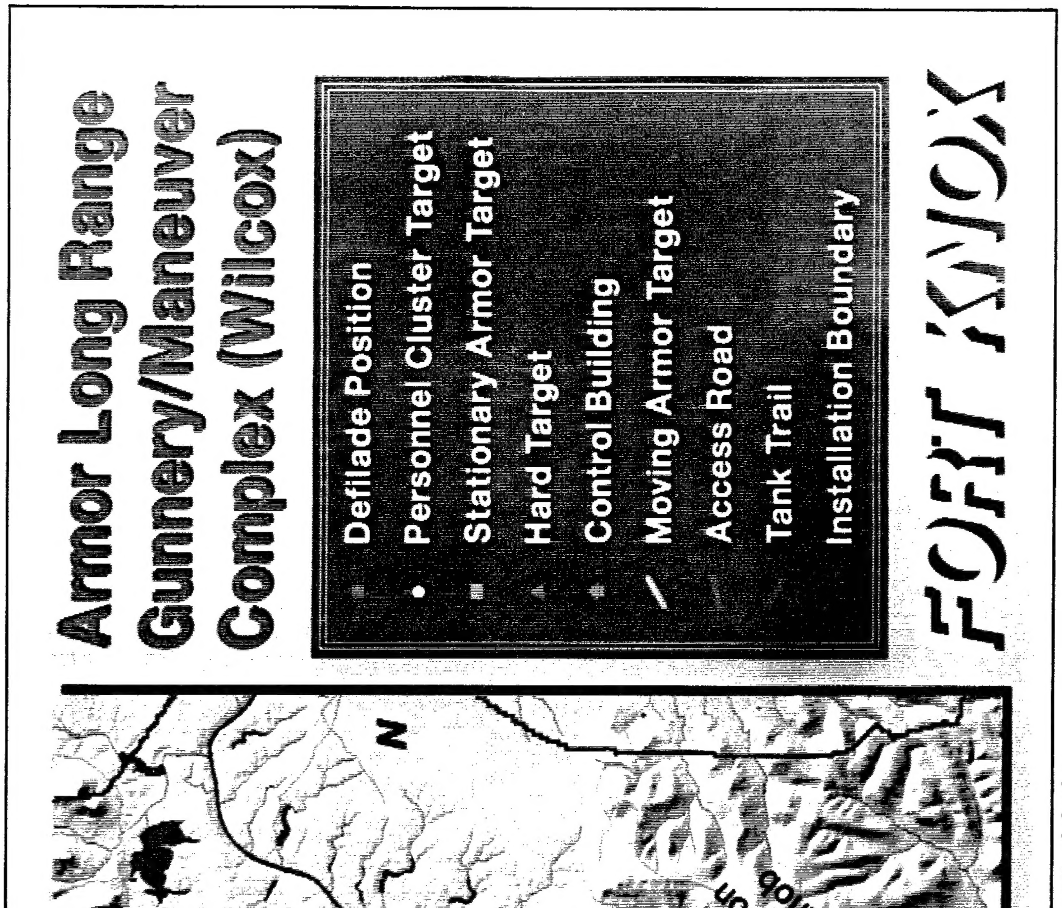

Figure C3. Plan view of Wilcox Range Maneuver Complex conceptual design.

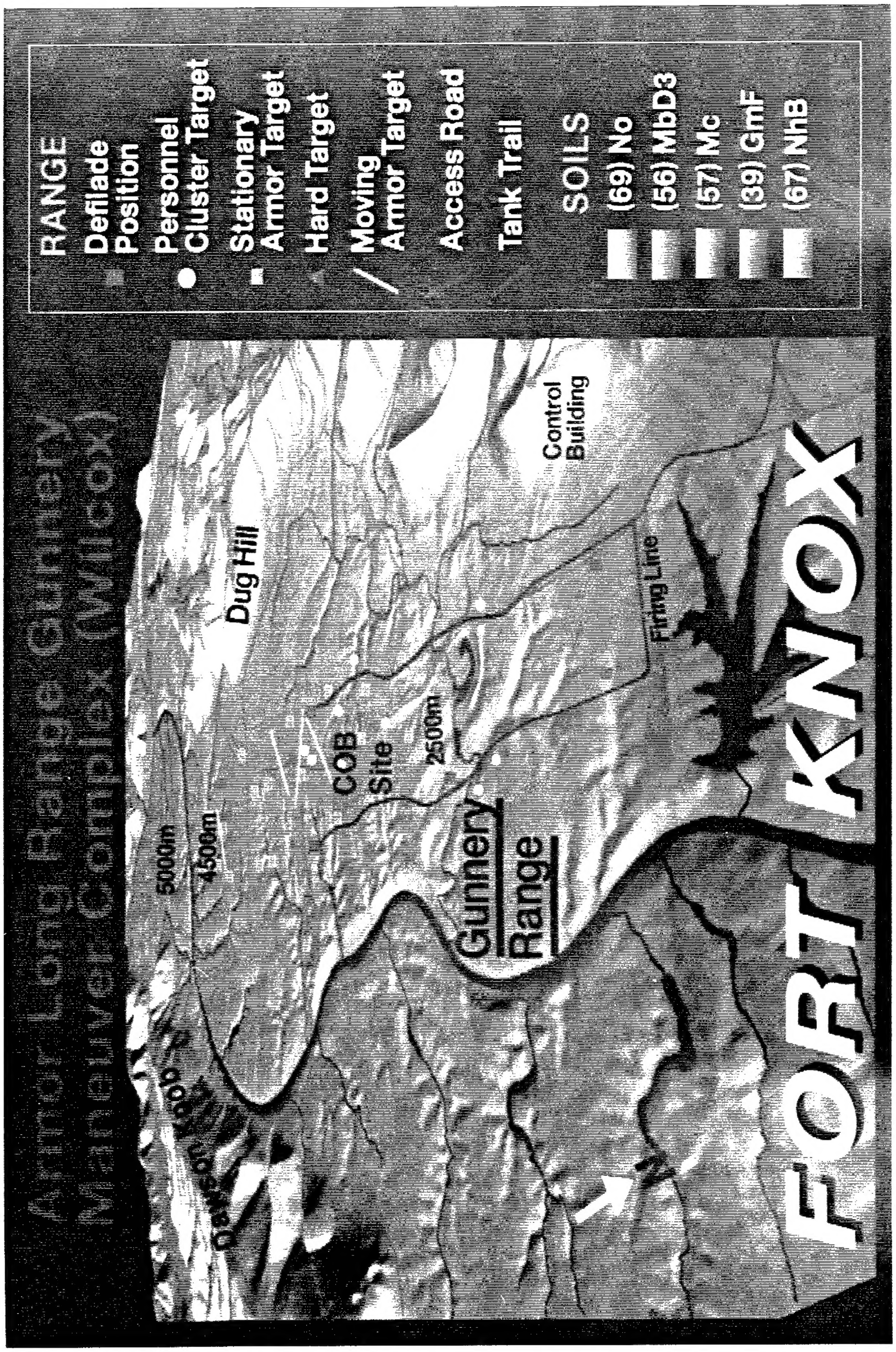

Figure C4. 3D view of maneuver complex with soils data overlaid.

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